Science for Preschoolers?
Yes and No

Front Porch Series Broadcast Calls

Randi Shapiro: Welcome to the Front Porch Series. I'm Randi Shapiro, Executive Director of the National Center on Quality Teaching and Learning. And on behalf of my colleagues here at NCQTL, I'd like to thank you for joining us today for another interesting presentation related to young children and learning.

Today's speaker is Dr. Rochel Gelman, Professor of Psychology and Cognitive Science at Rutgers University and Co-Director of the University – Rutgers University Center for Cognitive Science. Dr. Gelman co-authored "Preschool Pathways to Science: Facilitating Scientific Ways of Thinking, Talking, Doing, and Understanding." Dr. Gelman's research in developmental cognitive science works to uncover the ease with which young children acquire intuitive understandings of natural numbers and arithmetic, children's perceptions of separately movable animate and inanimate objects, and children's understanding that outcomes have causes.

There will be opportunity throughout the broadcast for participants to write in their questions. On the right-hand side of your screen, you may see something that says "Questions," and you can just jot it down, and then we will answer them. There will be 10 to 15 minutes at the end of Dr. Gelman's presentation for her to answer those questions.

So without further ado, we are delighted to have Dr. Gelman as our Front Porch Series. And it is my pleasure to turn the mic over to you, Dr. Gelman.

Dr. Rochel Gelman: Well, hello, everybody. Welcome. I start with the basic question of "What is science?" Well, science, like history and other subjects, are domains – organized domains of knowledge. In the case of science, it's the world and the world around us, or the surrounds. This includes biological and non-biological entities, as well as the materials in and around the world. But there's more to science than objects and materials and liquids and waters of other kinds.

There's an important question of "How do we do science?" It has its methods. We observe. We explore. We experiment, which means comparing and contrasting different conditions. We share our works, which means we document, we write it, we replicate the work to make sure it wasn't an accidental observation, and we generalize to new examples or new laws, and then proceed once again to observe, explore, experiment, and so on. But most importantly, we do have to record and date our work. For young children, they can draw what they have observed, whereas we can help them by writing down on their drawings in their science books what the drawing's about. Science language often uses complex language. For example, "The ice cubes will melt if we heat them or leave them out of the refrigerator;" not just, "The ice is cold."

Importantly, history is not a subject that dwells within the realm of science. The account of Newtonian mechanics, which is in science, is the same in different countries, texts, museums, different schools, homes, and the like. But when it comes to the body of history, which is to explain the past and people who live in it, we all know full well that these kinds of accounts can be changed. They're changed after wars, as one moves from one country to another where certain events are more salient for that country, and so on. Or we find, as women have, there are new documents that nobody ever read.

Now, there's a little bit of overlap, but mainly these are separate fields. And there you have, therefore, different concepts about what organizes the ideas within a field. Science concepts have organizing central, or what we'll call core, concepts. Not just "That's a cat," but "It's an animate thing," and I tell you it's a cat. You can then argue with me as to whether or not it's the kind of cat that's dangerous or not. Well, what do you mean by dangerous? Well, it comes very quickly at you. If it's a copy of a cat, you're not going to worry about that. So you'll know something deep about real animals as opposed to good copies of animals.

But most importantly for those involved with schools and young children, facts and terms do not stand alone. Their meanings are deeply related to the concepts they stand for. So if I tell you that an echidna is an animal, you know automatically that it eats, it breathes, has babies, and so on, whereas a toy dog does not. Well, this sounds pretty fancy.

Are we going to talk about science for preschoolers? My answer is maybe. There are some colleagues of mine, various universities, who say yes, that young children, like adults, are already scientists because they explore, they spontaneously ask questions like "why," "what's this," often over and over again – like pointing to a stair and saying, "What's this?" You say, "A stair." They point to another stair, you say, "A stair," and they do this over and over and over again. Yeah, that's asking a spontaneous question, but it's not something I think we see too often in science activities or classrooms.

And, yes, they're very interested in cause and effect and they know a lot about the difference between animate/inanimate, that plants grow, that animals grow, and they themselves grow. They can even keep track of the frequencies that matter: how many dogs their best friend has and [inaudible]. So maybe they all are scientists, as Gopnik and Schulz would want us to believe. But if that were the case, we would hardly be in the situation where everyone, from the president on, in this country is worried that we don't know anything about the STEM sciences.

So there's an alternative, and it's one I choose, which is to dub non-scientists "scientists-in-waiting," knowing enough, ready enough to build on what you already know to become a scientist and learn some of the math that goes with it. Well, I'm likely to get a response of, "Oh, come on." We know from Piaget and other developmental theorists, and even different cultures, that preschool children, no matter where they live, what neighborhood – a farm, a home – fail to conserve, classify, or order things. They're perception-bound. They're not logical.

They're certainly not at the right stage to talk to adults, because they're too young for abstract ideas. They can't systematically classify, so how could they possibly have understanding of the deep distinction between animate and inanimate and their differences, as well as the fact that even though they can't see it, animates energy for movement is from within the animal and external energy is needed to move inanimates?

Well, here's an example of what most people who do not think preschoolers are ready to do science or are likely to engage in. They will let children manipulate materials – very important. They can play with sand, water, blocks, and learn some terms. They can ask questions and explore. And as I said, they can repeat over and over again. And here's the child asking another adult I know a question about the same stair, and for three weeks.

Well, here's a kind of different case. [Cough] Excuse me. I have a very bad cough. Young children's museums – one I knew in Philadelphia was built for children seven years of age and younger, along with an adult who had to accompany them. And standing very attractively on the floor, what was called the How Many? Box. Well, about two-thirds of the adults didn't even go over to the box with the children. And the rest, only a few read what they had to read if the child was to know what the box was about. The adult was supposed to say, "How many wheels on a car?" "How many eggs in an egg carton?" "How many eyes on your face?" opening up a mirror so they could see two, and so on. Well, as it turned out, almost no adults bothered to read.

This became a very wonderful exploration device, but it wasn't for what it was built. It shouldn't take you too long to figure out that if you got near this box, it was unbelievably noisy. The kids went around opening and banging up and down the various doors, naming if they could, but having the time of their life looking at the pictures as they changed, and not ever – well, maybe one or two kids would count.

So, it's not enough to just observe or try any time or anything. Sometimes it's necessary to provide some hints – hence, again, the notion of scientists-in-waiting – if these children are to move on to become scientists. Now, you might say, "Well, what am I supposed to provide science and hints about? I don't know any science." Well, I'm not asking you to talk about gravity, mechanics, and incline planes or orbits of the moon, or even why the clouds. We want to avoid a push-down curriculum that takes pieces that you might have memorized for the kids, because we want to build up concepts from what they already know.

So, we want a build-up program and not a push-down program. And almost everywhere now that one goes around the United States – to museums or to classrooms or even to homes or stores – for children's materials, you'll find science areas. But to my amazement, most are not used. We encountered that problem and took it upon ourselves to do something that we're sure anybody can do.

Here is an example of a science center ready to be taken and put on a table but not being used. What is often included in most science centers is a balance scale or tube. We took one out to talk about during circle time, or what you might call quiet time. We talked about the parts, what their names were, we let the children feel the things that were going in, and so on. We might have done this for two, at most three, sessions. Some people will find they only need one; some will find they need more. That's all fine. And then we put them back into the science center. And I'm going backwards. Not good.

And this is what we did. Before we put the balance scale into this "experiment" in one classroom, we also went to another classroom and had a control group where they had a lesson on reading about animals, and again, interacting and playing with the toys that were relevant. And in both classrooms, we measured how much time the area of the science center was used – how much baseline activity. And now I can go forward again.

It's with the base – balance scale goes into the experimental conversation. The control class has – talks about animals. And then, we observed before and after these conversations to see what happened. And here you see a little girl from a school in downtown New Brunswick working, or if you like, playing with a balance scale. There's an apple in each, they don't weigh the same, and she's trying to balance, and so she's counting the number of blocks she has to put into there.

Not only could she play with this well, she got very interested in other materials and started to ask about them. Her friends came over and said, "What are you doing?" And before long, the science center was very popular and had miraculously grown in size. As you can see, the activity in dark black is that observed after the – the balance scale became part of an everyday-type conversation during quiet time, and the children's interest of being in it skyrocketed. With adults around, it isn't that big a deal to tell them what it's about. You will have used them in stores; you will have used them in elementary school. You understand that.

Again, here we are building a program that moves the children forward. There are principles that you can follow. The mind likes organization at all ages. It is the case that learning is easier when it is based on something you already know. Therefore, any education should build up from what we know kids do know. We cannot assume that environments that will be used as intended by us as adults will be automatically attended to and understood. It is, therefore, critical to pay attention to what we know or the kids are pointing to for your – to pay attention to it.

Another principle is: Use redundant examples in new settings over and over again. You record over and over again for different observations. You do other things over and over again in the same structural way, not in the exact memorized way. So you're going to make observations by passing, let's say, an apple around, and tell every child there is more than one apple. One way to observe and to write down at the same time what their observation is along beside their name, so you're also recording. They're eventually going to draw the apple, and you will help them date it.

Exploring goes very much along with observations, but often the child will explore something to attract attention. It's a good thing to go and ask them what they're exploring. And the child we are really fond of looked up at us and said, "First, I'm observating. I have to see what it looks like. Then I will go exploring for ones that are the same and different." This leads to organized build-up of knowledge; again, redundancy, not just repetition. Repetition matters, but redundancy is much more important.

So, for example, here we are observing and recording for an apple. That's Kim Brenneman who's talking about it. And now, she's going to pass the apple to my right, and every child is going to have time to touch it, turn it over, if they want to smell it, to feel it, to shake it, and report on an observation. She in turn has their names all written down and writes down what their observation is. That sheet will – will next go up on the blackboard.

And here is part of the next sequence, where there's an orange, and, again, they do observations and predictions. Now they're going to predict what they will find inside. And this child's drawing has a little seed on the inside and then one circle inside another circle. And the child has drawn what he considers, or she considers, the seed and the inside of the orange, and we write that down. Those of you who know the Reggio program know that this is a common feature of it.

And here we are again. We did, eventually, another situation with kids saying, "It feels hard;" "It's yellow;" "It has a stick on it;" "I see some green;" "I see some brown," and they're also learning this way that sometimes there's more than one correct answer.

Here is a bit of evidence on the animate and inanimate distinction from research with three- and four-year-olds. This was an experiment where basically all we did was drop on the floor pairs of look-alike animals. One was a photograph of a real animal and the other was a photograph of a very good copy that you'd find on the shelf of a very, very expensive store. The children's task was to take the pairs and put them in the zoo book or in the store book. And they could do this very well just looking at photographs, which means they were zeroing in on different material. The one on my left is the real bear, and if you look at it, it looks kind of real furry. The eyes on the right and the lines don't quite look right. And that seems to have been enough.

Here's another experiment that we did, again with three- and four-year-olds, and I've labeled some of them for you. For every picture they saw, they were asked whether the thing in the picture – "the thing," we never labeled them – could go up a hill on one trial and then down a hill on another trial. Almost all the children thought the echidna and the bug could go up and down hills by themselves, but neither statue could. So when we asked why of some children, they'd point to the feet and say, "Those aren't feet." Well we'd say, "But those are feet;" they'd say, "They're not real feet." And when they told us the echidna had feet, we said, "But I don't see any feet;" and the child said, "Well, they must have feet. They must be sitting on them."

Even more startling to us was they said the bug could do it. And many children had said the statues couldn't because one was too shiny. A bug is shiny. But instead of saying, "No, can't do it. It's too shiny," which would be perceptual failings, they pointed to the antlers or the little bits of hair on their feet. So they had the concept that was saying find the relevant biological material for animals and find the non-biological material for inanimates. Now, it's not as if they were saying this, but the concept itself was directing attention in different ways.

And here's a repeat of what I've just told you. But you can go on and build more knowledge about animals. No matter where you are in the United States, with rare exception, the climate will change. It could be hot, cold, full of snow and ice. And as the climate changes noticeably, so does what the children wear. And so we talk about this, and they answer that they wear sweaters, rain hats, gloves, long or short sleeves, bathing suits, carry umbrellas, never carry an umbrella in the desert but carry water and look for a tree to get shade from.

So, one can tally what children in particular environments do to protect themselves during different climates. And then we can count how many are wearing sweaters, how many are wearing coats, and go on to say, "Well, what do you think the animals do in the winter?" And then the adult might play a joke and say, "Well, do you think if we went to the supermarket we could buy them a coat?" And everybody will burst out laughing, "How silly! Don't do that. We don't do that." Well, what do they do? Well, we move on and have them explore materials that are relevant to animals.

So here's a little girl feeling materials that are made out of sheep, or not, and asking which one they think would keep them warmer. This is another case where we're interested in what do you do if you're a bear in the wintertime. Well, you eat a lot and you have a lot of blubber. And then to get the idea across that the blubber goes between the skin on the outside and the skin on the inside, we make blubber gloves, using for each hand two plastic gloves and filling them up with blubber, close them at the ends, and then the kids can put on a blubber glove and a plain glove, stick them in ice-cold water, and feel that one hand gets cold very, very fast and the other one doesn't get cold at all.

But you can do the same thing with feathers for birds and other animals. Or you can ask, "What if it starts to snow? Where do we go?" Well, we try to get inside a shelter, try to get inside a house, an igloo, a tent, a farmhouse, an apartment. Well, animals try to get under trees, or they migrate. That is, they travel to where it's warmer. Or, some of them put on a lot of feathers and find a place to hide inside a cave. There are all kinds of different solutions, but all animals are finding solutions to deal with the change in the weather just as people and children are. And so in this way, we are building up the fact that it's not just that we eat and drink, but we learn much more about what it means to be alive through a year of season change.

And, of course, almost everybody has a pumpkin. You can ask them to predict how many seeds there are on the inside. It'll take a long time, but they're very likely to want to try. The best way to get kids to want to try to count is to give them a goal, and now the goal would be seeds on the inside.

This is my final comment. Yes, science for young children if you're building up from what you have learned from us or others who study what young children are capable of doing. There's a caution. You need to spend more time – you may need more time to start in one setting than another. But that doesn't matter; take as much time as you feel you need. It'll get you there. The kids will get you there. Just remember, build on what you already know.

So by way of summary, young children do explore. We want to keep them exploring. They ask why and what; we want them to keep doing that. But we would like it better if they asked what will they find inside a nut, and then you sit around and try and open it. A hammer comes into play; they see you need a very hard instrument for a very hard shell. They know a lot about the difference between animate and inanimate. Almost anybody who works with young children know that plants grow; that plants who get water and plant food will grow rather well; that if you don't give them water and plant food, they'll get sick and they'll die; and animals and us also need food and water.

So, they can keep track of some frequencies that matter. And so maybe they already are scientists, but I still prefer to dub young children and almost everybody else as "scientists-in-waiting." Waiting, because we do know a lot from which we can build coherent knowledge and language and tools on the basis of what the young already know.

I thank you.